DOCKET FILE COPY ORIGINAL

AT&T

Richard N. Clarke

Room 5462C2
295 North Maple Avenue
Basking Ridge, New Jersey 07920
(908) 221-8685

EX PARTE OR LATE FILED

February 4, 1998

RECEIVED

FEB - 4 1998

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
1919 M. St., NW, Room 222
Washington, D.C. 20554

RE: Ex Parte Presentation – Proxy Cost Models
CC Docket No. 96-45

Dear Ms. Salas:

Pages 31 – 40 of the *HAI Model, Release 5.0a: Model Description* were inadvertently omitted from yesterday's filing of the complete documentation set. They are attached here.

Two copies of this Notice are being submitted to the Secretary of the FCC in accordance with Section 1.1206(a)(2) of the Commission's rules.

Sincerely,

Richard N. Clarke/ha

Richard N. Clarke

Attachment

cc: Chuck Keller
Robert Loube
Natalie Wales
Brad Wimmer
Sheryl Todd

As a result of this gross up process, the customer location file now contains records for each of the U.S.'s more than 100 million customer locations with a geocode (either calculated precisely or through the gross up process) associated with it.

5.5. Customer Location Clustering

5.5.1. General Criteria

The input development process next identifies all customer locations within a wire center's boundaries that are close enough together to be efficiently engineered as a single telephone plant serving area. This process is called clustering. While there are many available off-the-shelf clustering algorithms, efficient determination clusters of customer locations that are consistent with telephone engineering practices requires that certain engineering restrictions be imposed during the clustering process, and not afterward. Customer locations must meet the following criteria to be considered members of a particular cluster.

- No point in a cluster may be more than 18,000 feet distant (based on right angle routing) from the cluster's centroid.
- No cluster of nondegenerate area may exceed 1800 lines in size.[32]
- No point in a cluster may be farther than two miles from its nearest neighbor in the cluster.

Note that other than for the wire center boundary restriction, these criteria do not include any arbitrary geographic restrictions, such as clusters being restricted to lie within a single CBG, CB, or latitude/longitude grid cell. Thus, clusters developed pursuant to this process are likely to be the most closely representative of actual telephone distribution areas as determined by outside plant engineers. Note, however, that the last of these restrictions – no point in a cluster may be farther than 2 miles from its nearest neighbor – is not an absolute engineering limitation. It is used to ensure that customer locations that are separated by the given distance are not required to be clustered together. It is possible that efficient engineering of telephone distribution plant would suggest that a different, possibly larger value be chosen.[33]

[32] This restriction is based on the maximum unconcentrated lines capacity of an OC-3 fiber optic transmission system used to feed a DLC remote terminal (adjusted for a 90% rate of fill). This is consistent with current HM 5.0a practice that provides a separate channel for each line served by a DLC system. Because it is reasonable engineering practice to concentrate traffic on these large fiber optic DLC systems, future versions of the model may assume that traffic is concentrated on the fiber optic systems feeding DLC remote terminals. When such revisions to the HM become available, the customer location data will be reclustered with the appropriately enlarged maximum limit on cluster size. In all events, if single customer locations, such as a large office or apartment building, by themselves exceed 1800 lines, such clusters are not split. Rather, multiple DLC RTs/SAIs will be placed to serve such "oversized" clusters.

[33] Testing of different parameterizations for the maximum distance to a cluster point's nearest neighbor suggests that 2 miles is a reasonable national value.

5.5.2. Clustering Algorithm

The process used by the PNR clustering algorithm is as follows.

a) First, to provide a uniform geographic unit for clustering operations, all customer location geocodes associated with a particular wire center are "rasterized" into 150 foot cells that overlay the geographic rectangle covering the wire center's service area.[34]

b) The algorithm then inspects all neighboring cells (e.g., all cells that have their center within a 150 foot radius of the center of the initial cell) to see if any are populated with customer locations. If one of these neighboring raster cells is populated, the algorithm first checks to see whether clustering that cell (and its immediately surrounding neighbors) with the initial cell would violate any of the clustering restrictions (i.e., create a cluster that has points more than 18,000 feet from the cluster centroid, create a cluster of more than 1800 lines, or include a point more than 2 miles from its nearest neighbor).[35] If none of these conditions would be violated, the adjoining cell plus its immediate neighbors will be added to the initial cell's cluster

c) This process continues on to the next unclustered populated cell and performs the analysis described in step (b), above. This repeats until no more unclustered cells exist.

d) The process then restarts at step (b), but uses a 300 foot search for populated neighboring cells.

e) This continual enlargement of the search for neighboring populated cells continues on until no more cells can be added to the cluster without violating one or more of the engineering requirements. At this point, the algorithm is complete.

Clusters that contain five or more customer locations are classified as "main" clusters. Clusters that contain from one to four customer locations are called "outlier" clusters. Outlier clusters may be linked to their "home" main cluster via "chains" that string together other outlier clusters that home on the same main cluster. The process of determining the routing of the chain is as follows.

---

[34] Rasterization at this level is a process whereby all customer locations that are within the 150 foot square cell are counted as being placed at the center of the cell. Rasterization to 150 foot square cells ensures that the mathematical clustering process can proceed efficiently, and that nonmeaningful distinctions in customer location are ignored. Increasing the raster to 300 or 500 feet would speed up the clustering process dramatically, and still provide a very acceptable level of precision in cluster formation. Note, too, that the PNR calculation of 150 foot raster cells is precise – based on the local latitude of the cell. Thus, raster cells do not enlarge as one moves south toward the equator.

[35] Because the rasterization into 150 foot square cells may cause customer locations that actually are in the farthest corner of a cell to be considered at the cell's center, the clustering algorithm will actually check to ensure that no cells added to a cluster exceed 17,700 (= 18,000 - 2*150) feet from the cluster's centroid.

a) The clustering algorithm first calculates the distance between each cluster and every other cluster in the wire center service area.

b) The algorithm then determines the shortest distance between any two clusters, and associates these two clusters together.

c) Next, the algorithm determines the next shortest distance between any two clusters or cluster chains, and associates these together.

d) This process continues until all outliers are chained to a main cluster.

In addition to creating chains to associate outlier clusters to a main cluster, the clustering algorithm calculates the area of the rectangle covering the convex hull of each cluster and the "aspect ratio" of this rectangle.[36]

When this process is completed, the main cluster and its subtending outliers are considered to constitute one serving area.

The description the HM 5.0a Distribution Module in Section 6.3 provides greater detail on the model's engineering of outside plant to serve main and outlier clusters.

5.6. PointCode Translation Processes

PointCode is a Microsoft Access '97 database process that translates between coordinate systems, computes distances and assigns additional characteristics to cluster records. Among the activities executed by PointCode are the following.

Convert the latitude and longitude coordinates provided by PNR for cluster centroids to V&H coordinates. Ensure that modeled distribution rectangles have an aspect ratio and area that reflects a minimum dimension equal to twice the default drop length for that lines density range. Calculate radial distances between main clusters and their serving wire center. Calculate radial distances between outlier clusters and main clusters.

Compute omega angles between main feeders and the clusters they serve and compute alpha angles between clusters and their subfeeders. Calculate rectilinear (right angle) distances between main clusters and their serving wire center, and between outlier clusters and main clusters.

On the basis of the characteristics of the covering CBG, assign terrain and lines density zone characteristics to the cluster.

[36] The aspect ratio is the ratio of the North-South length to the East-West length of the rectangle covering the convex hull of the cluster.

6. Module Descriptions

6.1. Input Data Files

6.1.1. Demographic and Geological Parameters

Demographic and geological parameters are obtained from a database developed by PNR and Associates of Jenkintown, PA. Section 5, above, explains in detail how these data are developed. The data file resulting from these processes is organized by state and telephone company (study area). Each customer location cluster (both main and outlier) identified in the wire center service areas of the LEC modeled appears as a separate record in this Microsoft Access 97 database. Each of these cluster records contains the following information:

- Identity of the LEC and wire center serving the cluster;
- Locational information about the cluster relative to its wire center, the predominant CBG in which it falls, its nearest neighboring cluster and associated distances;
- Area and dimensional measurements of the cluster and its lines density;
- Terrain and geological parameters;
- Number of telephone lines by type;
- Number of households and number and type of housing units;
- Number of business firms and employees;
- Information about the fraction of a wire center's total lines are represented by this cluster, the average loop distribution distance of its subtending outlier clusters and total number of outlier lines.

The complete list of data fields in the Cluster Input data table is as follows:

Cluster Input Data Table		
State	Total Area	1-HU detach
CLLI	Aspect Ratio	1-HU attach
Company	Company State	HU-2
Neca_ID	Density Lines/SQ Mile	HU-4
Group	Rock Depth	HU-5-9
CBG	Rock Hard	HU-10-19
Cluster Group	Surf Text	HU-20-49
Overall Quad	Water Depth	HU-50+
Overall Omega	Total Lines	Mobile
Overall Alpha	Total Bus Lines	Other
Radial Dist Feet	Total Res Lines	Firms
Cluster or Outlier Check	Special Lines	Employees
Outlier Quad	Public Lines	FracWCLine
Outlier Omega	Single Line Business	AvgLoopDist
Outlier Alpha	Households	TotOutLine
Outlier Radial Distance		

6.1.2. Wire Center Locations and Interoffice Distances

Calculations to determine total route-miles of interoffice facilities require as inputs several distance measures. These include the distances between each LEC EO and the tandem switch that is assumed to serve it, the distance between the EO and the STP pair that serves it, distances between STPs, distances between tandem offices, and the V&H (vertical and horizontal) coordinates of each switching entity. These data are calculated from a database licensed from Bellcore, referred to as the Special LERG Extract Data ("SLED") file which contains information from the Local Exchange Routing Guide ("LERG"). The SLED includes the V&H coordinates of each switching entity, and the nature of the entity, e.g., end office, tandem, STP, multiple use, etc. Appendix D provides an outline of the process used to develop these distance measures.

6.1.3. ARMIS Data

These data are obtained from the 1996 ARMIS 43-08 Operating Data Reports. ARMIS data are submitted to the FCC annually by all Tier 1 LECs.[37] The following elements of these data are extracted.

[37] See, Reporting Requirements for Certain Class A and Tier 1 Telephone Companies (Parts 31, 43, 67 and 69 of the FCC's Rules), CC Docket No. 86-182, 2 FCC Rcd 5770 (1987) (ARMIS Order), modified on recon., 3 FCC Rcd, 6375 (1988). Tier 1 LECs are those with more than $100 million in annual revenues from regulated services. This includes over 50 carriers.

- The number of residential access lines, including all residential switched access lines, including those with flat rate (1FR) and measured rate (1MR) service.

- The number of business access lines, including analog single business lines, analog multi-line business lines and digital business lines; these totals include flat rate business (1FB) and measured rate business (1MB) single lines, PBX trunks, Centrex lines, hotel/motel, long distance trunks and multi-line semi-public lines.[38]

- Analog and digital special access lines, including dedicated lines connecting end users' premises to an IXC POP, but do not include intraLATA private lines.

- Public access lines, which include lines associated with coin (public and semi-public) phones, but exclude customer owned pay telephone lines.[39]

For companies that do not report ARMIS, HM 5.0a makes use of data reported in various sources listed earlier in Section 5.1.

6.1.4. User Inputs

This category comprises over 1400 user-definable values. These range from the price of network components, to the percentage of joint-use end offices and tandem offices to capital structure. HAI has supplied default values for each of these variables based on its collective judgment, as augmented by subject matter experts in various areas of network technology, operations and economics. Users can vary these default parameters to reflect unusual local conditions. Appendix B contains a complete description of these variables, along with the default values that have been assigned to them.

6.2. Outside Plant Engineering

The Distribution and Feeder Modules are the main modules controlling the engineering of outside plant. While Sections 6.3 and 6.4 below discuss the unique aspects of each of these modules, this section describes several features and assumptions common to both modules.

Figure 5 shows the basic outside plant serving configuration used by HM 5.0a.

[38] *Id.* at 1-2.

[39] *Id.* at 2.

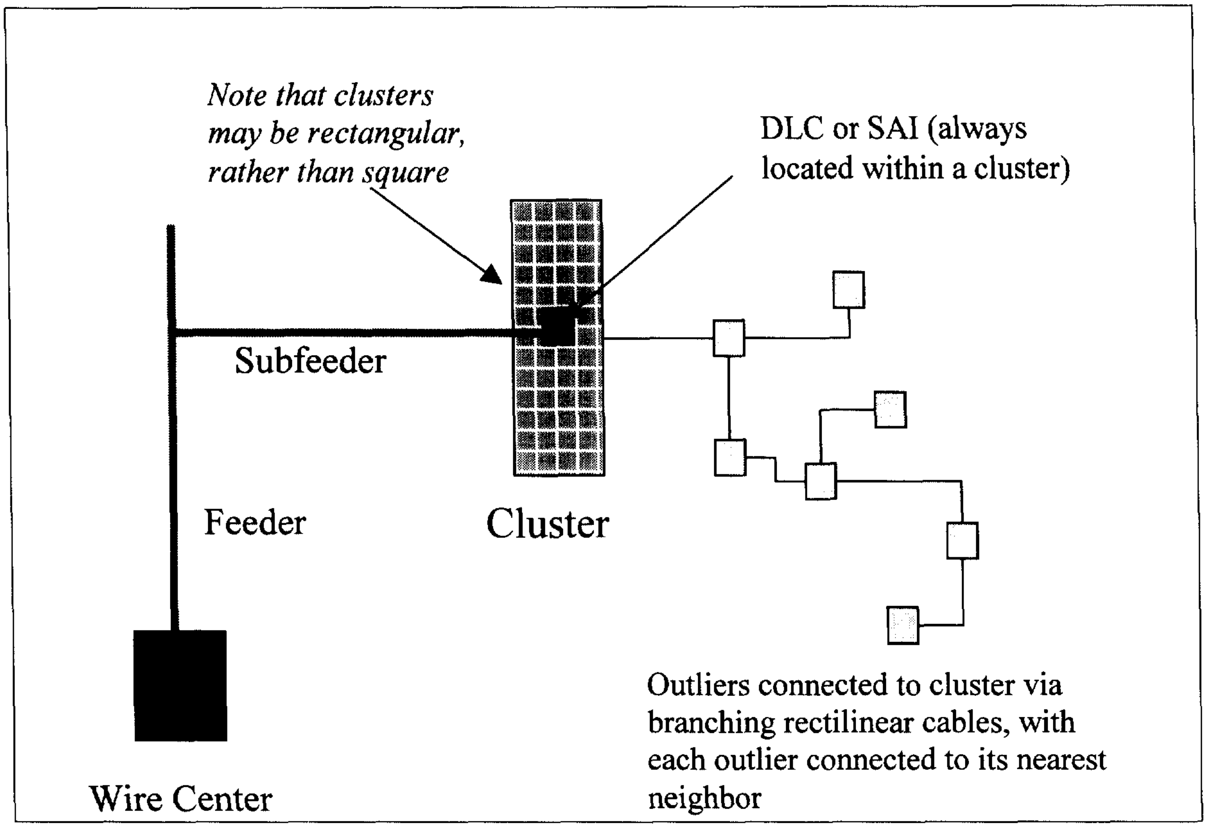

Figure 5 Loop Outside Plant Configuration

The Model assumes a main cluster and its subtending outlier clusters constitute a serving area. Main feeder cable (that may be shared with other main clusters) and subfeeder cable extend from the wire center to the centroid of the main cluster. If the main and subfeeder cable are copper, the subfeeder cable terminates in an SAI. If the feeder and subfeeder are fiber, the subfeeder either terminates at a single DLC RT and adjacent SAI located at the centroid of the main cluster, or extends via fiber "connecting cables" from the centroid to two or more DLC RTs and adjacent SAIs located within the cluster so as to ensure no copper distribution cable length exceeds the user-adjustable maximum analog copper distance. The choice between copper and fiber main feeder and subfeeder is made according to the criteria discussed in Section 6.3.5, below. In all cases, analog copper distribution cables extend from the SAI(s) to their subtending customer locations within the main cluster in a backbone and branch fashion. The data process used to locate customers and identify population clusters also determines the "aspect ratio" of the overlying rectangle that defines the boundary of a main cluster, and is used in determining the location of the fiber DLC RTs and layout of the backbone and branch distribution arrangement.

From the centroid of a main cluster, copper cables extend to each outlier cluster that is served from that main cluster, with each outlier cluster connected to its nearest neighbor (either the main cluster or another outlier cluster), via a right-angle route. These copper cables terminate either at an SAI or T1 remote terminal at the centroid of the outlier cluster – depending on whether the distance the signal needs to be carried falls short of, or exceeds, a user-adjustable 18,000 foot threshold. Subscribers in outlier clusters are assumed to be located on routes within the outlier cluster that may be distinct from the route traveled by the cable feeding the outlier's SAI or T1 remote terminal from the main cluster. Because of this, a separate analog copper distribution cable is run from the centroid of the outlier to individual customer locations. The model does, however, assume a moderate amount of structure sharing between these two cables within the outlier cluster because of the partial coincidence of their routes.

6.2.1. Outside Plant Structures

Outside plant structure refers to the set of facilities that support, house, guide, or otherwise protect distribution and feeder cable. There are three types of structure: aerial, buried and underground.

1) *Aerial Structure*

Aerial structure typically consists of poles.[40] Pole investment is a function of the material and labor costs of placing a pole. A user-adjustable input allows the customization of the labor component of pole investment to local conditions. HM 5.0a computes the total investment in aerial distribution and feeder structure within a CBG by evaluating relevant parameters, including the distance between poles, the investment in the pole itself, the total cable sheath mileage, and the fraction of aerial structure along the route.

The model assumes forty-foot Class 4 poles. The spacing between poles for aerial cable is fixed within a given density range but may vary between density ranges. The number of poles on a given route is calculated as:

1 + (route distance/pole spacing), rounded up.

2) *Buried Structure*

Buried structure consists of trenches and related protection against water and other intrusions. The additional cost for protective sheathing and waterproof filling of buried cable is a fixed amount per foot in the case of fiber cable and is a multiplier of cable cost in the case of copper cable.[41] The total investment in buried structure is a function of total route mileage, the fraction of buried structure, investment in protective sheathing and filling, and the density-range-specific cost of trenching.

[40] In the two highest density zones, most aerial structure is assumed to be intrabuilding riser cable and "block cable" attached to buildings.

[41] The default values for sheathing are $0.20 per foot for fiber, and a multiplier of 1.04 for copper. The different treatment reflects the fact that the outside diameter of fiber cable is essentially constant for different strand numbers, while copper cable diameter increases with the number of pairs it contains.

3) *Underground Structure*

Underground structure consists of conduit and, for feeder plant, manholes and pullboxes. Manholes are used in conjunction with copper cable routes; pullboxes are used on routes that are served exclusively by fiber cable. The total investment in a manhole varies by density zone and includes materials, frame and cover, excavation, backfill, and site delivery. Investment in fiber pullboxes is a function of materials and labor. Underground cables are housed in conduit facilities that extend between manholes or pullboxes. The total investment in underground structure is a function of total route mileage, the fraction of underground structure, investment in conduit manholes, and pullboxes, and the cost of trenching needed to hold the conduit.

In each line density range, there may be a mixture of aerial, buried and underground structure. For example, in downtown urban areas, it is frequently necessary to install cable in underground conduit systems, while rural areas may consist almost exclusively of aerial or direct-buried plant. Suburban areas may have a more balanced mixture of all three structure types. Also, as described more completely in Section 6.2.5, below, the HM 5.0a permits certain amounts of substitution between buried and aerial structure based on abnormal local cost conditions.

Users can adjust the mix of aerial, underground and buried cable assumed within the model. These settings may be specified by density zone for fiber feeder, copper feeder, and copper distribution cables. Appendix B includes detailed lists of the HAI Model structure default values for aerial, buried and underground plant.

6.2.2. Terrain and Its Impact on Placement Costs

HM 5.0a incorporates the effects of geological factors on required structure investment. Terrain factors considered by the model include bedrock depth, rock hardness, surface soil type, and water depth. Each serving area is assumed to have the terrain characteristics of the CBG in which it predominately falls.[42]

If the rock depth in a serving area is less than a user-definable rock depth threshold, a rocky placement multiplier increases structure investment in poles, conduit placement,

[42] Main clusters and their subtending subclusters are not restricted to fall entirely within a single CBG. Such a restriction would impose an artificial limitation on the "natural" serving areas being identified by the Model. As a result, the predominant CBG must be used to determine the terrain characteristics. If appropriately digitally-encoded terrain data become available, a more precise determination of the terrain characteristics of serving areas crossing several CBGs could be made.

and trenching, because it is more difficult to bury cable in rock than in soil.[43] If bedrock does not exist within the placement depth, then the surface soil texture is examined to determine if soil can be plowed, or if more expensive placement techniques must be used. The model causes the rock placement multiplier to vary with rock depth; the entire multiplier applies if the rock depth is zero, and the value tapers linearly to unity at the user-defined placement depth.

Certain kinds of surface textures may increase the cost of structure. When these are encountered, the model extracts a multiplier from a lookup table in the distribution module inputs worksheet, and applies it to the structure investment as determined by the density zone. If both difficult soil conditions and rocky conditions are encountered, the model will multiply the structure investment by the sum of the rock placement and surface texture multipliers minus one.[44]

Water table depth does not have a significant effect on trenching costs, but may affect the cost of placing manholes. The model increases manhole placement costs by a user-adjustable amount (default value of 20%) of the nominal placement cost whenever the water table depth is less than a user-adjustable minimum depth whose default value is five feet.

Labor costs for placement may be adjusted for regional variation by the application of a user-entered labor adjustment factor.

6.2.3. Structure Sharing

Outside plant structures are generally shared by LECs, CATV operators, electric utilities, and others including competitive access providers ("CAPs") and IXCs. To the extent that several utilities may place cables in common trenches, or on common poles, it is appropriate to share the costs of these structure items among these users. Furthermore, manholes may be shared by all low voltage utilities as well. The HAI model assumes sharing of structure costs among the various utilities that occupy the structure. Although assumptions concerning the degree of sharing are user-adjustable; the default values used in the HAI Model reflect best forward-looking, economic practices for the various utilities involved.

6.2.4. Lines Density Considerations

A number of parameters, such as the fill factors for distribution and feeder copper cable and the mixture of underground, buried, and aerial plant, are dependent on line density of

[43] The HAI Model default maximum values for geological factors are as follows: rock depth threshold causing increased trenching cost, 24 inches; hard rock placement multiplier, 3.5; and soft rock placement multiplier, 2.0.

[44] Section 6.2.5, below, indicates how the Model automatically will adjust the fractions of buried and aerial structure to reflect economic choices based on abnormal local cost conditions for these structure types.